34. (New) The aluminum alloy of claim 12, wherein the alloy further comprises Mn as a purposely added alloying addition in an amount up to about 1 wt %.

35. (New) The aluminum alloy of claim 12, wherein the alloy is substantially free of Ag.

36. (New) The aluminum alloy of claim 12, wherein the alloy is substantially free of Zn.

37. (New) The aluminum alloy of claim 12, wherein the alloy is substantially free of Sc.

REMARKS

Upon entry of this Amendment, Claims 1-8, 12, 16-22 and 26-37 will be pending in the application.

The undersigned would like to thank Examiner Ip for the courtesies extended during the interview conducted January 16, 2002. The claims have now been amended as proposed during the interview, and are believed to be in condition for allowance.

By the present Amendment, independent Claims 1 and 12 have been amended to recite that the alloy is capable of attaining a fracture toughness K_{R25} of at least 91.5 ksi$\sqrt{\text{in}}$ when the alloy is in a cold worked, naturally aged temper. Basis for this recitation is provided in the specification, for example, at page 13, line 25. Independent Claims 1 and 12 have also been amended to recite a minimum Mg level of about 0.6 wt %. Basis for this recitation is provided in the specification, for example, at page 7, lines 28 and 29, as well as Claims 1 and 12 as originally filed.

Independent Claim 12 has also been amended to recite that Cu, Mg and Li are present in the alloy in the form of a solid solution, and the alloy comprises clusters of atoms of solute.

Minor grammatical amendments have been made to dependent Claims 5-8, 19-22 and 27.

New Claims 28 and 33, which depend from Claims 1 and 12 respectively, recite a minimum Mg level of 1 wt %. Basis for this recitation is provided in the specification, for example, at page 2, line 28, page 4, lines 4-7, and Fig. 1.

Claims 29 and 34, which depend from Claims 1 and 12 respectively, recite that the alloy comprises Mn as a purposely added alloying addition in an amount up to about 1 wt %. Basis for this recitation is provided in the specification, for example, at page 5, lines 17-23.

Claims 30 and 35, which depend from Claims 1 and 12 respectively, recite that the alloy is substantially free of Ag. Basis for this recitation is provided in the specification, for example, at page 5, lines 23-25, page 9, lines 24 and 25, and page 10, lines 6 and 7 and 18 and 19.

Claims 31 and 36, which depend from Claims 1 and 12 respectively, recite that the alloy is substantially free of Zn. Basis for this recitation is provided in the specification, for example, at page 5, lines 23-25, page 9, lines 24 and 25, and page 10, lines 6 and 7 and 18 and 19.

Claims 32 and 37, which depend from Claims 1 and 12 respectively, recite that the alloy is substantially free of Sc. Basis for this recitation is provided in the specification, for example, at page 5, lines 23-25, page 9, lines 24 and 25, and page 10, lines 6 and 7 and 18 and 19.

As discussed during the interview, the references applied in the Office Action disclose aluminum alloys which include Cu, Mg and Li amounts in widely ranging amounts, but none of the references specifically teach that the combination of Cu, Mg and Li should be controlled within the ranges recited in independent Claims 1 and 12. None of the alloys actually made in accordance with the applied references contained Cu, Mg and Li in the amounts presently claimed. For example, the applied references direct one skilled in the art to use more than the presently claimed maximum amount of 0.99 wt % in order to achieve favorable properties such as increased strength. The relatively low amount of Li recited in the present claims, in combination with the claimed amounts of Cu and Mg, is contrary to the teachings of the applied references.

Moreover, none of the applied references teach or suggest an alloy composition and microstructure wherein Cu, Mg and Li are present in the alloy in the form of a solid solution, and interaction of Li ions in the solid solution gives rise to the formation of clusters of atoms of solute as presently claimed.

Furthermore, none of the applied references teach or suggest an alloy that is capable of attaining a fracture toughness K_{R25} of at least 91.5 ksi$\sqrt{}$in when the alloy is in a cold worked, naturally aged temper as presently claimed. The recited fracture toughness represents an unexpectedly improved result in comparison with conventional alloys.

<u>U.S. Patent No. 5,122,339 to Pickens et al.</u>

Pickens et al. '339 discloses aluminum-base alloys which may contain 3.5-7 wt % Cu, 0.05-1.5 wt % Mg, 0.01-2 wt % Ag, 0.1-4 wt % Li, and 0.1-2 wt % grain refiner. Although the reference broadly mentions a range of 0.1 to 4 wt % Li, the reference further states that the highest strengths are attained with Li levels of from about 1 to about 1.5 % with decreases below and above these percentages (see column 4, lines 23-25). None of the alloys actually made in accordance with the Pickens et al. '339 reference fall within the presently claimed ranges. For example, the alloys made in accordance with the reference contained from 1.21 to 2.1 wt % Li, well above the maximum of 0.99 wt % Li recited in independent Claims 1 and 12. Reading the Pickens et al. '339 reference as a whole, one skilled in the art would be lead to use greater amounts of Li than presently claimed in order to achieve optimal mechanical properties.

Pickens et al. '339 does not mention Cu, Mg and Li being present in the alloy in the form of a solid solution, and further does not mention interaction of lithium ions in the solid solution giving rise to formation of clusters of atoms of solute, as presently claimed. Instead, Pickens et al. '339 appears to teach away from the presently claimed microstructure by stating that the ultra-high strength of the disclosed alloys may result from the formation of precipitates (T_1 phase (Al_2CuLi)). The alloy microstructure disclosed by Pickens et al. '339 is thus distinct from the presently claimed microstructure in which clusters of atoms of solute are formed.

Furthermore, the Pickens et al. '339 reference does not teach or suggest that the disclosed alloys are capable of attaining a fracture toughness K_{R25} of at least 91.5 ksi$\sqrt{}$in when in a cold worked, naturally aged temper, as presently claimed. The recited fracture toughness represents an unexpectedly improved result which further serves to distinguish over Pickens et al. '339.

It is therefore submitted that the Pickens et al. '339 patent, when read as a whole, does not fairly teach or suggest the alloy compositions and microstructure recited in independent Claims 1 and 12.

The dependent claims recite additional features which further serve to distinguish over Pickens et al. '339. For example, dependent Claims 29 and 34 require the presence of Mn as an alloying addition in amount up to about 1 wt %. The alloys made in accordance with the Pickens et al. '339 reference do not contain Mn. Dependent Claims 30 and 34 recite that the alloy is substantially free of Ag, while the Pickens et al. '339 reference requires Ag.

U.S. Patent No. 5,211,910 to Pickens et al.

Pickens et al. '910 discloses aluminum-base alloys comprising from about 1 to about 7 wt % Cu, from about 0.1 to about 4 wt % Li, from about 0.01 to about 4 wt % Zn, from about 0.05 to about 3 wt % Mg, from about 0.01 to about 2 wt % Ag, and from about 0.01 to about 2 wt % grain refiners. Although the reference mentions an Li range of from about 0.1 to about 4 wt %, the reference further states that peak strengths fall within the range of from about 1.1 to about 1.4 wt % Li (see column 11, lines 59-64). The alloys actually made in accordance with Pickens et al. '910 contain from 1.25 to 2.4 wt % Li, well above the maximum Li level of 0.99 wt % recited in Claims 1 and 12. When read as a whole, the Pickens et al. '910 reference would lead one skilled in the art to use more Li than presently claimed in order to achieve optimal mechanical properties.

Pickens et al. '910 does not teach or suggest an alloy microstructure as presently claimed including clusters of atoms of solute. Instead, Pickens et al. '910 apparently teaches away from the presently claimed composition and microstructure by stating that Cu concentrations above about 3.0 wt % are useful in order to provide sufficient amounts of Cu to form high volume fractions of T_1 (Al_2CuLi) strengthening precipitates in artificially aged tempers (see column 11, lines 33-40). Pickens et al. '910 further teaches away from the presently claimed microstructure by stating that the use of Mg in the alloys enhances nucleation of strengthening precipitates (see column 2, lines 12-23). The reference does not teach or suggest an alloy composition and microstructure in which Cu, Mg and Li are present in an alloy in the form of a solid solution, and

interaction of Li ions in the solid solution gives rise to the formation of clusters of atoms of solute, as presently claimed.

Furthermore, Pickens et al. '910 does not disclose that the alloys are capable of attaining a fracture toughness K_{R25} of at least 91.5 ksi$\sqrt{in}$ in a cold worked, naturally aged temper. The recited fracture toughness represents an unexpectedly improved result, which further serves to distinguish over Pickens et al. '910.

It is therefore submitted that the Pickens et al. '910 patent, when read as a whole, does not fairly teach or suggest the presently claimed invention, as recited in Claims 1 and 12.

The dependent claims recite additional features which further serve to distinguish over Pickens et al. '910. For example, Claims 30 and 34 recite that the alloy is substantially free of Ag, while the Pickens et al. '910 reference requires the presence of Ag. The alloys actually made in accordance with the reference contained from 0.1 to 0.4 wt % Ag. Claims 31 and 35 recite that the alloy is substantially free of Zn, while Pickens et al. '910 requires Zn. The alloys actually made in accordance with the reference include from 0.25 to 2.0 wt % Zn.

<u>U.S. Patent No. 5,259,897 to Pickens et al.</u>

Pickens et al. '897 discloses Al-Cu-Li-Mg alloys. In one embodiment, the reference mentions that the aluminum alloy may contain 3.5-5.0 Cu, 0.8-1.8 Li, 0.25-1.0 Mg and 0.01-1.5 grain refiner. However, the reference further states that the tensile properties of the alloys are highly dependent on Li content, with peak strengths attained with Li concentrations of about 1.1 to 1.3 wt %, with significant decreases below about 1.0 % (see column 20, lines 6-10). The actual alloys made in accordance with the Pickens et al. '897 patent contained either 1.3 wt % Li or 1.7 wt % Li. Reading the Pickens et al. '897 reference as a whole, one skilled in the art would be lead to use greater amounts of Li than presently claimed in order to achieve optimal mechanical properties.

Pickens et al. '897 does not teach or suggest the presently claimed alloy composition and microstructure in which Cu, Mg and Li are present in the alloy in the form of a solid solution, and further does not teach or suggest that interaction of lithium ions in the solid solution gives rise to formation of clusters of atoms of solute, as

presently claimed. Instead, Pickens et al. '897 apparently teaches away from the presently recited composition and microstructure by stating that concentrations above about 3.5 wt % Cu are necessary to provide sufficient Cu to form high volume fractions of T_1 (Al_2CuLi) strengthening precipitates in the artificially aged tempers (see column 13, lines 58-62). The reference further states that advantageous properties are obtained when Li content is in the range of 1.0-1.4 wt % and Mg content is in the range of 0.3-0.5 wt %, showing that the type and extent of strengthening precipitates is critically dependent on the amounts of these two elements (see column 14, lines 48-53). The presently claimed clusters of atoms of solute are distinct from the precipitates disclosed in Pickens et al. '897.

Furthermore, Pickens et al. '897 does not disclose that the alloys are capable of attaining a fracture toughness K_{R25} of at least 91.5 ksi$\sqrt{in}$ in a cold worked, naturally aged temper, which represents an unexpectedly improved result achieved in accordance with the presently claimed invention.

It is therefore submitted that the Pickens et al. '897 patent, when read as a whole, does not fairly teach or suggest the presently claimed invention.

JP 01025954 Abstract

The JP 01025954 abstract discloses an Al alloy for aircraft containing 0.5-5.0 Cu and 0.5-4.0 Li. The abstract also apparently discloses that the alloy can contain either zero Mg or 0.5-6.0 Mg. The only specific aluminum alloy disclosed in the abstract contained 2.1 Li, 2.7 Cu, 0.04 Si, 0.05 Fe, 0.02 Ti, 0.002 B and 0.0005 Be. The Li level of 2.1 % of the disclosed alloy is well above the maximum Li level of 0.99 wt % as presently claimed. The Cu level of 2.7 % of the disclosed alloy is below the minimum level of about 3 wt % Cu as presently claimed.

The JP 01025954 abstract does not teach or suggest the presently claimed alloy composition and microstructure in which Cu, Mg and Li are present in the alloy in the form of a solid solution, and further fails to teach or suggest that the interaction of lithium ions in the solid solution gives rise to formation of clusters of atoms of solute, as presently claimed. The abstract apparently teaches away from the presently claimed microstructure by stating that the disclosed alloy is manufactured without solution

treatment. Such a lack of solution treatment could indicate to one skilled in the art that a solid solution of the alloying elements is not formed, contrary to the presently claimed invention.

Furthermore, the JP 01025954 abstract does not disclose that the alloy is capable of attaining a fracture toughness K_{R25} of at least 91.5 ksi$\sqrt{in}$ in a cold worked, naturally aged temper, as presently claimed.

It is therefore submitted that the JP 01025954 abstract does not teach or suggest the presently claimed invention.

WO 9532074 Abstract

The WO 9532074 abstract discloses the addition of scandium to many different types of aluminum alloy compositions. In one embodiment, Sc is added to an Al-Cu-Li-Ag-Mg alloy. According to the abstract, such an aluminum alloy may contain 3.5-5.5 % Cu, 0.40-2.0 % Li, 0.01-0.80 % Ag, 0.01-1.5 % Mg, 0.02-0.5 % Sc and 0-1.0 Zr.

The WO 9532074 abstract does not teach or suggest the presently claimed alloy composition and microstructure in which Cu, Mg and Li are present in the alloy in the form of a solid solution, and further fails to teach or suggest that the interaction of lithium ions in the solid solution gives rise to formation of clusters of atoms of solute, as presently claimed.

The WO 9532074 abstract does not disclose that the alloys are capable of attaining a fracture toughness K_{R25} of at least 91.5 ksi$\sqrt{in}$ in a cold worked, naturally aged temper, as presently claimed.

Therefore, the WO 9532074 abstract does not teach or suggest the presently claimed invention.

The dependent claims recite additional features which further serve to distinguish over the WO 9532074 abstract. For example, Claims 30 and 34 recite that the alloy is substantially free of Ag, while the WO 9532074 abstract requires the presence of Ag in the Li-containing alloy. Claims 32 and 37 recite that the alloy is substantially free of Sc, while the WO 9532074 abstract requires the presence of Sc.

WO 9212269 Abstract

The WO 9212269 abstract broadly discloses aluminum alloys containing 0.2-5.0 Li, 0.05-12.0 Zn, 0-5.0 Mg, 6.5 maximum Cu, 1.0 maximum Zr, 2.0 maximum Mn, 2 maximum Ag, 0.5 maximum Fe and 0.5 maximum Si. The abstract further states that the preferred aluminum alloy contains 1.5-3.0 Li (above the presently claimed range), 2.5-2.90 Cu (below the presently claimed range), 0.2-2.5 Mg, 0.2-11.0 Zn, 0.08-0.12 Zr, 0-1.0 Mn and Fe and Si impurities 0.1 % maximum each. The only specific aluminum alloy disclosed in the abstract contained 2.17 Li (well above the presently claimed range), 2.79 Cu (below the presently claimed range), 0.49 Zn, 0.25 Mg, 0.07 Zr, 0.35 Mn and 0.08 V. Based on the WO 9212269 abstract, one skilled in the art would be lead to use more Li than presently claimed, and less Cu.

The WO 9212269 abstract does not teach or suggest the presently claimed alloy composition and microstructure in which Cu, Mg and Li are present in the alloy in the form of a solid solution, and further fails to teach or suggest that the interaction of lithium ions in the solid solution gives rise to formation of clusters of atoms of solute, as presently claimed.

Furthermore, the WO 9212269 abstract does not disclose that the alloy is capable of attaining a fracture toughness K_{R25} of at least 91.5 ksi$\sqrt{}$in in a cold worked, naturally aged temper, as presently claimed.

It is therefore submitted that the WO 9212269 abstract does not teach or suggest the presently claimed invention.

The dependent claims recite additional features which further serve to distinguish over the WO 9212269 abstract. For example, Claims 31 and 35 recite that the alloy is substantially free of Zn, while the WO 9212269 abstract discloses that Zn is a required alloying element.

DE 2810932 Abstract

The DE 2810932 abstract discloses broad ranges of aluminum alloy compositions suitable for resistance welding. The aluminum alloys may contain 2-4 Mg, 0.4-08 Li, 0.1-0.7 Mn, 10.2 maximum Cu, 0.45 maximum Fe, 0.45 maximum Si, 0.4 maximum Cr, 0.1-0.2 Ti, 0.3 maximum Zn, 0.3 maximum Ni, 0.05-0.15 V and 0.15

maximum Zr. The DE 2810932 abstract does not fairly teach or suggest the presently claimed alloy composition and microstructure. For example, the range of 0 to 10.2% Cu disclosed in the DE 2810932 abstract provides no guidance to one skilled in the art as to the specific amount of Cu that should be used. Undue experimentation would be required. Nowhere does the abstract indicate to one skilled in the art to use from about 3 to about 4.5 wt % Cu, as presently claimed. Furthermore, the abstract directs one skilled in the art to use a relatively high level of Mg (2-4 %) versus the relatively low Mg level presently claimed (from about 0.6 to about 2 wt %).

Furthermore, the DE 2810932 abstract does not teach or suggest that the presently claimed alloy composition and microstructure in which Cu, Mg and Li are present in the alloy in the form of a solid solution, and further does not teach or suggest that interaction of lithium ions in solid solution gives rise to formation of clusters of atoms of solute, as presently claimed. Although the abstract states that the disclosed alloy contains Li in solid solution, the abstract does not teach or suggest that Mg or Cu would be present in the alloy in the form of a solid solution. Instead, at such high Mg levels (2-4 %) and Cu levels (up to 10.2 %), one skilled in the art would not expect such elements to be present in the form of a solid solution.

The DE 2810932 abstract also fails to disclose that the alloys are capable of attaining a fracture toughness K_{R25} of at least 91.5 ksi$\sqrt{in}$ in a cold worked, naturally aged temper, as presently claimed.

It is therefore submitted that the DE 2810932 abstract does not fairly teach or suggest the presently claimed invention.

Summary

The prior art of record fails to teach or suggest aluminum alloys having the composition and microstructure as recited in independent Claims 1 and 12. It is therefore submitted that Claims 1-8, 12, 16-22 and 26-35 are in condition for allowance. Accordingly, an early notice of allowance of this application is respectfully requested.

In the event that any outstanding matters remain in connection with this application, the Examiner is invited to telephone the undersigned at (412) 263-4340 to discuss such matters.

Respectfully submitted,

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Marked-up Version of Claims

1. (Four times amended) An aluminum alloy consisting essentially of from about 3 to about 4.5 wt % copper, from about [1.0] <u>0.6</u> to about 2 wt % magnesium, and lithium in an amount of from 0.01 to 0.99 wt. %, wherein the copper, magnesium and lithium are present in the aluminum alloy in the form of a solid solution, where interaction of lithium ions in the solid solution gives rise to formation of clusters of atoms of solute providing fatigue resistant alloys<u>, and wherein the alloy is capable of attaining a fracture toughness K_{R25} of at least 91.5 ksi$\sqrt{\text{in}}$ when the alloy is in a cold worked, naturally aged temper</u>.

5. (Amended) The aluminum alloy of claim 1, including a dispersoid selected from the group consisting of chromium, vanadium, titanium and zirconium and mixtures thereof in [the] <u>an</u> amount [of from] <u>up to</u> about [0.0 to] 0.6 wt.%.

6. (Amended) The aluminum alloy of claim 1, including a dispersoid selected from the group consisting of manganese, nickel, iron, hafnium, scandium and mixtures thereof in [the] <u>an</u> amount [of from] <u>up to</u> about [0.0 to] 1.0 wt.%.

7. (Amended) The aluminum alloy of claim 1, including a first dispersoid selected from the group consisting of chromium, vanadium, titanium, zirconium and mixtures thereof in [the] <u>an</u> amount [of form] <u>up to</u> about [0.0 to] 0.6 wt.% and a second dispersoid selected from the group consisting of manganese, nickel, iron, hafnium, scandium and mixtures thereof in [the] <u>an</u> amount of from about 0.04 to 1.0 wt.%.

8. (Amended) The aluminum alloy of claim 1, including other alloying elements selected from the group consisting of zinc, silver, silicon and mixtures thereof in [the] <u>an</u> amount [of from] <u>up to</u> about [0.0 to] 2.0 wt.%.

12. (Four times amended) An aluminum alloy consisting essentially of copper, magnesium and lithium <u>in the form of a solid solution</u>, the lithium content being in an amount of from 0.01 to 0.99 wt %, effective to avoid formation of an Al_3Li phase, <u>wherein the alloy comprises clusters of atoms of solute and the alloy is capable of attaining a fracture toughness K_{R25} of at least 91.5 ksi$\sqrt{\text{in}}$ when the alloy is in a cold worked, naturally aged temper,</u> and <u>wherein</u> the copper and magnesium weight percent

values fall[ing] within a closed area on a graph with wt % copper on the x-axis and wt % magnesium on the y-axis, said closed area being bounded by generally straight lines joining the following points:

POINT 1 = 3 Cu, [1.0] <u>0.6</u> Mg

POINT 2 = 4.28 Cu, [1.0] <u>0.6</u> Mg

POINT 3 = 3.7 Cu, 2 Mg

POINT 4 = 3 Cu, 2 Mg

and back to POINT 1.

19. (Amended) The aluminum alloy of claim 12, including a dispersoid selected from the group consisting of chromium, vanadium, titanium and zirconium and mixtures there in [the] <u>an</u> amount [of from] <u>up to</u> about [0.0 to] 0.6 wt.%.

20. (Amended) The aluminum alloy of claim 12, including a dispersoid selected from the group consisting of manganese, nickel, iron, hafnium, scandium and mixtures there in [the] <u>an</u> amount [of from] <u>up to</u> about [0.0 to] 1.0 wt.%.

21. (Amended) The aluminum alloy of claim 12, including a first dispersoid selected from the group consisting of chromium, vanadium, titanium, zirconium and mixtures thereof in [the] <u>an</u> amount [of from] <u>up to</u> about [0.0 to] 0.6 wt.% and a second dispersoid selected from the group consisting of manganese, nickel, iron, hafnium, scandium and mixtures thereof in the amount of from about 0.04 to 1.0 wt.%.

22. (Amended) The aluminum alloy of claim 12, including other alloying elements selected from the group consisting of zinc, silver, silicon and mixtures thereof in [the] <u>an</u> amount [of from] <u>up to</u> about [0.0 to] 2.0 wt.%.

27. (Twice amended) The aluminum alloy of Claim 12, wherein said lithium content comprises a maximum of 0.8 wt % and where interaction of lithium ions in the solid solution gives rise to formation of <u>the</u> clusters of atoms of solute [providing] <u>which provide</u> fatigue resistant alloys.

New Claims 28-37

28. (New) The aluminum alloy of claim 1, wherein the Mg comprises at least about 1 wt % of the alloy.

29. (New) The aluminum alloy of claim 1, wherein the alloy further comprises Mn as a purposely added alloying addition in an amount up to about 1 wt %.

30. (New) The aluminum alloy of claim 1, wherein the alloy is substantially free of Ag.

31. (New) The aluminum alloy of claim 1, wherein the alloy is substantially free of Zn.

32. (New) The aluminum alloy of claim 1, wherein the alloy is substantially free of Sc.

33. (New) The aluminum alloy of claim 12, wherein the Mg comprises at least about 1 wt % of the alloy.

34. (New) The aluminum alloy of claim 12, wherein the alloy further comprises Mn as a purposely added alloying addition in an amount up to about 1 wt %.

35. (New) The aluminum alloy of claim 12, wherein the alloy is substantially free of Ag.

36. (New) The aluminum alloy of claim 12, wherein the alloy is substantially free of Zn.

37. (New) The aluminum alloy of claim 12, wherein the alloy is substantially free of Sc.